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Anne Dailey

12/20/1999 07:28 AM

To: Steven Hughes, Dan Winstanley, Don Heinle, Harry Ohlendorf, Dana Houkal, Joe Goulet/R10/USEPA/US

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Subject: Spokane River environmental data

Hi All -

Please see the attached from Matt Kadlec regarding his environmental data search along the Spokane River. Please contact Matt directly if you have questions about his submittal. Thanks. Anne

Matt - Thanks so much for putting this together - it looks like it should be quite useful!

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----- Forwarded by Anne Dailey/R10/USEPA/US on 12/20/1999 07:22 AM -----



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12/17/1999 05:43 PM

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Subject: Spokane River environmental data

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Seasons greetings,

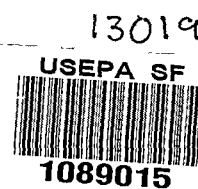
The results of my Spokane River environmental data search are attached.

<<Spokane studies.doc>>

Matt Kadlec, Ph.D.  
Environmental Assessment Program  
Washington Department of Ecology  
PO Box 47600  
Olympia, WA 98504-7600  
Voice: 360-407-6771 Fax: 360-407-6884



- Spokane studies.doc



**To:** Ann Daily, Don Heinle  
**From:** Matt Kadlec  
**Subject:** Spokane River Environmental Data Search Results  
**Date:** December 16, 1999  
**Cc:** John Roland, Fred Kirchner

The results of my Spokane River environmental data search are as follows. For convenience, these data sources are listed in separate categories (biological community data, tissue metal concentrations, sediment data, water quality data, and habitat assessment data), along with the reach or reaches involved. Some of these reports are not among the documents on the CH2MHill/URS Greiner "Electronic Document Reference Library for the Coeur d' Alene Basin RI/FS". Upon request, I will provide those you still require. substantial metals contamination within the wetted width of the Spokane at many point along its length does not preclude the chance of contamination in floodplain and upland or areas: However, I did not find any information metals in any media beyond the river itself. Please distribute this memorandum as appropriate.

## Ecological Data

### Fisheries Assessments

Gibbons et al. 1984 -- Upper Spokane River  
Pfeiffer 1985 -- Lower Spokane River  
Kleist 1987 -- Lower Spokane River  
Bennett and Underwood 1988 -- Upper Spokane (in Idaho)  
Johnson 1997 -- Upper Spokane River

### Invertebrate Assessments

Gibbons et al. 1984 -- Upper Spokane River  
Pfeiffer 1985 -- Lower Spokane River  
Kleist 1987 -- Lower Spokane River

### Periphyton Assessment

Gibbons et al. 1984 -- Upper Spokane River

### Plankton Assessments

Gibbons et al. 1984 -- Upper Spokane River  
Pfeiffer 1985 -- Lower Spokane River  
Kleist 1987 -- Lower Spokane River

### Special Status Species and Sensitive Habitats

Gamon 1999 -- Spokane River (Appendix 1)  
Robinette 1999 -- Spokane River (Appendix 2)

## Tissue Metal Concentrations

### Biofilm

Farag, et al. 1998. – Upper Spokane River

### Fish

Bailey and Saltes 1982 – Upper Spokane River  
Saltes and Bailey 1984 – Upper Spokane River  
Bailey and Singleton 1984 – Upriver dam  
Beckman et al. 1985 – Spokane Arm  
Hopkins et al. 1985 – Nine Mile Dam and Up River Dam  
Johnson et al. 1988 -- Lake Roosevelt  
Johnson et al. 1990 – Spokane Arm  
Serdar et al. 1994 – Long Lake  
Johnson 1994 -- Idaho to Spokane Arm  
Munn et al. 1995. -- Lake Roosevelt  
Farag et al. 1998. – Upper Spokane River

### Invertebrates

Funk et al. 1973 – Upper Spokane River  
Moore et al. 1996 – Upper Spokane River  
Farag et al. 1998 – Upper Spokane River

### Periphyton

Farag et al. 1998. – Upper Spokane River (in Idaho)

### Phytoplankton

Funk et al. 1973 – Upper Spokane River

## Sediments

### Metal Concentrations

Beckman et al. 1985 – Spokane Arm  
Johnson et al. 1988 -- Lake Roosevelt  
Johnson et al. 1990 – Spokane Arm  
Johnson 1991 – Lake Roosevelt  
Serdar et al. 1994 – Long Lake  
Bortleson et al. 1994. -- Spokane Arm, Long Lake  
Moore et al. 1996 – Upper Spokane River  
Farag et al. 1998. – Upper Spokane River (in Idaho)  
USGS/WDOE (Appendix 3) --10 sites along main stem

### Grain-Size Proportion < 63-um

USGS/WDOE (Appendix 3) --10 sites along main stem

## Substrate Description (Embeddedness)

Falter and Mitchell 1982 - Upper Spokane (in Idaho)  
Pfeiffer 1985 -- Lower Spokane River  
Kleist 1987 -- Lower Spokane River  
Bennett and Underwood 1988 -- Upper Spokane (in Idaho)  
Johnson 1997 -- Upper Spokane River

## Water Quality Data

### Zinc, Lead, Cadmium, etc.

Yearsley 1980, 1981 -- Upper Spokane River & Idaho  
Bailey and Saltes 1982 -- Upper Spokane River  
Funk et al. 1983 -- Upper Spokane River to State  
Gibbons et al. 1984 -- Upper Spokane River  
Bailey and Singleton 1984 -- Upriver dam  
Beckman et al. 1985 -- Spokane Arm  
Reif 1986 -- Upriver dam  
Johnson et al. 1988 -- Lake Roosevelt  
Chern 1989 -- Upriver dam  
Johnson et al. 1990 -- Spokane Arm  
Johnson 1991 -- Lake Roosevelt  
Hallinan et al. 1991 -- Upriver dam  
Joy 1992 -- Upriver dam  
Stinson 1993 -- Upper Spokane River  
Zheng 1995 -- Upper Spokane River  
Pelletier 1996 -- RM-63.5, 64.5, 85.3, 96  
Wiggins et al. 1996 -- Upper Spokane River  
Hopkins and Johnson 1997 -- Idaho, Long Lake  
WDOE-AMS 1994-1997 -- State line and Riverside Park  
Farag, et al. 1998. -- Upper Spokane River (in Idaho)  
USGS WATSTORE 1998 -- Long Lake to upper river, 6 sites

### Nutrients

Gibbons et al. 1984 -- Upper Spokane River  
WDOE-AMS 1994-1997-- Spokane River  
USGS 1998 (WATSTORE) -- Long Lake to upper river, 6 sites

### Dissolved Oxygen

Gibbons et al. 1984 -- Upper Spokane River  
Pelletier 1995 -- RM-72.8, 77.5, 80.6, 81.9, 82.9, 83.5  
WDOE-AMS 1994-1997-- Spokane River

### Temperature

Gibbons et al. 1984 -- Upper Spokane River  
Kleist 1987 -- Lower Spokane River  
Pelletier ca. 1995a -- RM-63.5, 64.5, 85.3, 96  
Pelletier ca. 1995b -- RM-72.8, 77.5, 80.6, 81.9, 82.9, 83.5  
Johnson 1997 -- Upper Spokane River  
WDOE-AMS 1994-1997-- Spokane River

USGS 1998 (WATSTORE) -- Long Lake to upper river, 6 sites

## pH

Pelletier 1994 -- RM-63.5, 64.5, 85.3, 96  
Pelletier 1995 -- RM-72.8, 77.5, 80.6, 81.9, 82.9, 83.5  
WDOE-AMS 1994-1997 Spokane River  
USGS 1998 -- Long Lake to upper river, 6 sites

## Solids

Gibbons et al. 1984 -- Upper Spokane River  
Pelletier 1995 -- RM-63.5, 64.5, 85.3, 96  
WDOE-AMS 1994-1997 Spokane River

## Turbidity

WDOE-AMS 1994-1997 Spokane River

## Habitat Data (Riparian area, or channel morphology-pool/riffle ratio, or flow, etc.)

Kleist 1987 --Lower Spokane River  
Bennett and Underwood 1988 - Upper Spokane (in Idaho)  
Johnson 1997 -- Upper Spokane River  
USGS 1998 (WATSTORE) -- Long Lake to upper river, 6 sites

## Complete Citations

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L. Beckman, J. Novotny, W. Persons, and T. Terell. 1985. Assessment of the Fisheries and Limnology of Lake F.D. Roosevelt., 1980-83. Prep. for U.S. Bureau Reclamation. U.S. Fish and Wildlife Service. FW-14-06-009-904.

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W. Funk, F. Rabe, R. Filby, P. Dunigan, N. Thompson, R. Condit, P. Bennett, K. Shah, 1973. The Biological Impact of Combined Metallic and Organic Pollution in the Coeur d'Alene--Spokane River Drainage System

A. Farag, D. Woodward, J. Goldstein, W. Brumbaugh and J. Meyer. 1998. Concentrations of metals associated with mining waste in sediments, biofilm, benthic macroinvertebrates, and fish from the Coeur d'Alene River basin, Idaho. Archives of Environmental Contamination and Toxicology 34:119-127.

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A. Johnson, D. Norton, and B. Yake. 1988. An Assessment of Metals Contamination of Lake Roosevelt. Washington. State Dept. Ecology, Olympia.

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Art Johnson. 1991. Review of Metals, Bioassay, and Macroinvertebrate Data from Lake Roosevelt Benthic Samples Collected in 1989. Memorandum to C. Nuechterlein. Washington State Dept. Ecology, Olympia.

A. Johnson, D. Serdar, and D. Davis. 1994. Results of 1993 Screening Survey on PCBs and Metals in the Spokane River. WDOE Pub. 94-E24.

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Barry Moore, Arden Thornburg, John Schaumlöffel, and Royston Filby. 1996. Chironomid deformity rates, metal body burdens, and sediment metal concentrations from the Coeur d'Alene/Spokane River systems. Washington Water Research Center – USDOI.

M. Munn, S. Cox, and C Dean. 1995. Concentrations of Mercury and Other Trace Elements in Walleye, Smallmouth Bass, and Rainbow Trout in Franklin D. Roosevelt Lake and the Upper Columbia River, Washington, 1994. USGS Open-File Rept. 95-195.

Greg Pelletier, 1994. Cadmium, Copper, Mercury, Lead, and Zinc in the Spokane River: Comparisons with Water Quality Standards and Recommendations for Total Maximum Daily Loads. Washington State Dept. Ecology, Olympia. Pub. No. 94-99. (*Spokane R metals study data on Pb, Zn, Cd, Hg, Cond., Alk., Cl, TSS, Hard., K, TOC, Mg, Cu, Nitrate/Nitrite, TDS, Ca, Na, SO<sub>4</sub>, Temp., pH*).

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Zheng. 1995. M.S. Thesis. Eastern Washington University, Cheney WA



## Appendix 1

December 13, 1999

WASHINGTON STATE DEPARTMENT OF

### **Natural Resources**

JENNIFER M. BELCHER

Commissioner of Public Lands

Matt Kadlec, Ph.D.  
Environmental Assessment Program  
Department of Ecology  
PO Box 47600  
Olympia WA 98504-7600

**SUBJECT: Spokane River Remedial Investigation / Feasibility Study - Contamination from the Bunker Hill, Idaho Superfund Site**

We've searched the Natural Heritage Information System for information on rare plants in the vicinity of the Spokane River. We have enclosed a summary of known locations of rare plant occurrences in your study area, as well as a list of rare plant species that may occur in the river habitats you described. There may be other significant plant species that could occur along the river - the enclosed lists are based on an initial review of available information.

The information provided by the Washington Natural Heritage Program is based solely on existing information in the database. In the absence of field inventories, we cannot state whether or not a given site contains high quality ecosystems or rare species; there may be significant natural features in your study area of which we are not aware. These data are being provided to you for informational and planning purposes only - the Natural Heritage Program has no regulatory authority.

If you have the opportunity, visit our website at <http://www.wa.gov/d> and click on *Conservation/Protection*. Please do not hesitate to call me at (360) 902-1667 if you have any questions, or by E-mail: [sandra.moody@wadnr.gov](mailto:sandra.moody@wadnr.gov).

Sincerely,

Sandy Swope Moody, Environmental Coordinator  
Washington Natural Heritage Program  
PO Box 47016  
Olympia WA 98504-7016

Enclosures

1111 WASHINGTON ST SE I PO BOX 47000 1 OLYMPIA, WA 98504-7000  
FAX: (360) 902- 7 775 1 TTY: (360) 902-1125 1 TEL: (360) 902- 1000  
Equal Opportunity/Affirmative Action Employer

RECYCLED PAPER

*The attached lists were prepared by John Gamon, Washington Natural Heritage Program Department of Natural Resources, transmitted to Matt Kadlec from Sandra Moody (360-902-1667) December 1999.*

WASHINGTON NATURAL HERITAGE INFORMATION SYSTEM  
ENDANGERED, THREATENED AND SENSITIVE PLANTS  
IN THE VICINITY OF SPOKANE RIVER  
REQUESTED BY DEPARTMENT OF ECOLOGY

Data Current as of December 1999  
Page 1 of 2

TOWNSHIP, RANGE AND SECTION	ELEMENT NAME-	STATE STATUS	FEDERAL STATUS
T27N R39E S10	<i>Carex hystericina</i> (porcupine sedge)	S	
T27N R39E S14 NE	<i>Antennaria parvifolia</i> (Nuttall's pussy-toes)	S	
T27N R39E S14 SW	<i>Antennaria parvifolia</i> (Nuttall's pussy-toes)	S	
T27N R39E S14 NE of SE S13 NW of SW	<i>Hackelia cinerea</i> (gray stickseed)	S	
T27N R39E S13 S half	<i>Carex hystericina</i> (porcupine sedge)	S	
T27N R39E S13 SW S24	<i>Hackelia cinerea</i> (gray stickseed)	S	
T27N R39E S24 NE	<i>Spiranthes porrifolia</i> (western ladies-tresses)	S	
T27N R39E S24 SE	<i>Carex hystericina</i> (porcupine sedge)	S	
T27N R40E S19 W half	<i>Carex hystericina</i>	S	

	(porcupine sedge)		
T27N R40E S20 SE S29	<i>Carex hystericina</i> (porcupine sedge)	S	
T27N R40E S20 E half S21 NW	<i>Carex hystericina</i> (porcupine sedge)	S	
T27N R40E S21 N half S22 N half	<i>Carex hystericina</i> (porcupine sedge)	S	
T27N R40E S21 N half S22	<i>Antennaria parvifolia</i> (Nuttall's pussy-toes)	S	

WASHINGTON NATURAL HERITAGE INFORMATION SYSTEM  
 ENDANGERED, THREATENED AND SENSITIVE PLANTS  
 IN THE VICINITY OF SPOKANE RIVER  
 REQUESTED BY DEPARTMENT OF ECOLOGY

Data Current as of December 1999  
 Page 2 of 2

TOWNSHIP, RANGE AND SECTION	ELEMENT NAME	STATE STATUS	FEDERAL STATUS
T27N R40E S11 SE S12 SW	<i>Carex hystericina</i> (porcupine sedge)	S	
T27N R40E S01 SW	<i>Hackelia cinerea</i> (gray stickseed)	S	
T27N R40E S01 E half	<i>Carex hystericina</i> (porcupine sedge)	S	
T27N R40E S01 NE	<i>Antennaria parvifolia</i> (Nuttall's pussy-toes)	S	
T26N R42E S07 S half S17 NWofNW	<i>Hackelia cinerea</i> (gray stickseed)	S	
T26N R42E S28 SE	<i>Antennaria parvifolia</i> (Nuttall's pussy-toes)	S	
T25N R42E S02 SW S11 NE	<i>Cryptantha spiculifera</i> (Snake River cryptantha)	S	
T25N R42E S15 E half	<i>Spartina pectinata</i> (prairie cordgrass)	S	

**WASHINGTON NATURAL HERITAGE INFORMATION SYSTEM**  
**Endangered, Threatened, and Sensitive Vascular Plants**

**Federal Status definitions:**

**LE = Listed Endangered:** Any taxon which is in danger of extinction throughout all or a significant portion of its range and which has been formally listed as such in the Federal Register pursuant to the Federal Endangered Species Act.

**LT = Listed Threatened:** Any taxon which is likely to become endangered within the foreseeable future throughout all or a significant portion of its range and which has been formally listed as such in the Federal Register pursuant to the Federal Endangered Species Act.

**PE = Proposed Endangered:** Any taxon which is in danger of extinction throughout all or a significant portion of its range and which has been proposed for listing as such in the Federal Register pursuant to the Federal Endangered Species Act.

**PT = Proposed Threatened:** Any taxon which is likely to become endangered within the foreseeable future throughout all or a significant portion of its range and which has been proposed for listing as such on the Federal Register pursuant to the Federal Endangered Species Act.

**C = Candidate species:** Taxa for which current information indicates the probable appropriateness of listing as Endangered or Threatened.

**SC = Species of Concern:** Species whose conservation standing is of concern but for which status information is still needed. Species of concern lists are not published in the Federal Register.

**State Status definitions:**

**E = Endangered:** Any vascular plant taxon in danger of becoming extinct or extirpated from Washington within the foreseeable future if factors contributing to its decline continue. Populations of these taxa are at critically low levels or their habitats have been degraded or depleted to a significant degree.

**T = Threatened:** Any vascular plant taxon likely to become Endangered in Washington within the foreseeable future if factors contributing to its population decline or habitat degradation or loss continue.

**S = Sensitive:** Any vascular plant taxon that is vulnerable or declining and could become Endangered or Threatened in the state without active management or removal of threats.

**X = Possibly Extinct or Extirpated from Washington:** Based on recent field searches a number of plant taxa are considered to be possibly extinct or extirpated from Washington. Taxa in this group are all high priorities for field investigations. If found, they will be assigned one of the above status categories.

**R = Review:** Taxa of potential concern, but for which no status has yet been assigned. Group 1 = Taxa in need of additional field work before a status can be assigned. Group 2 = Taxa with unresolved taxonomic questions.

**W = Watch:** Taxa more abundant and/or less threatened in Washington than previously assumed.

**Washington Natural Heritage Program  
Department of Natural Resources  
December 1999**

Species Known to Occur Along the Spokane River in Washington State

<i>Antennaria parvifolia</i>	adjacent uplands
<i>Carex hystericina</i>	riparian areas/wetlands/shoreline of impounded lacustrine areas
<i>Cryptantha spiculifera</i>	adjacent uplands (sandy slopes)
<i>Hackelia cinerea</i>	adjacent uplands (exposed basalt)
<i>Oxytropis campestris</i> var. <i>columbiana</i>	riparian (cobbly/sandy at river's edge); historically known only
<i>Spartina pectinata</i>	riparian/shoreline of impounded lacustrine areas
<i>Spiranthes porrifolia</i>	adjacent uplands

Additional Species That May Occur Along the Spokane River in Washington State

<i>Carex buxbaumii</i>	wetlands
<i>Carex comosa</i>	riparian areas/wetlands/shoreline of impounded lacustrine areas
<i>Cicuta bulbifera</i>	wetlands/riparian areas/shoreline of impounded lacustrine areas
<i>Epipactis gigantea</i>	riparian areas/wetlands/shoreline of impounded lacustrine areas
<i>Geum rivale</i>	wetlands/riparian areas
<i>Hypericum majus</i>	riparian areas/wetlands/shoreline of impounded lacustrine areas
<i>Impatiens aurella</i>	wetlands/riparian areas
<i>Ribes oxyacanthoides</i> ssp. <i>irriguum</i>	riparian/adjacent uplands
<i>Rotala ramosior</i>	riparian areas/wetlands/shoreline of impounded lacustrine areas
<i>Sanicula marilandica</i>	riparian
<i>Tauschia tenuissima</i>	wetlands
<i>Teucrium canadense</i> ssp. <i>viscidum</i>	wetlands

Please note: there may other special species that occur along the Spokane River - this list is based on an initial review of information currently available.

Kevin W. Robinette  
Habitat Biologist  
Priority Habitats and Species Program  
Washington Department of Fish and Wildlife  
Spokane, Washington  
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### Appendix 3

Washington Dept. of Ecology Data on Spokane River Sediment Samples Collected in Oct./Dec. 1998 with Art Horowitz,  
USGS<sup>1</sup>

Reach →	Upriver		9-Mile	Long Lake					Little Falls	Spokane Arm			Hangman Cr.	Deep Cr.	Little Spokn	Liberty Lk
USGS Sample ID	SRG-4 1	SRG-4 2	SRG-5 7	SRG-9	SRG-9	SRG-1 2	SRG-1 3	SRG-1 3	SRG-5 5	SRG-3 3	SRG-2 3	SRG-2 8			SRG-1 0	SRG-6 0
WDOE Sample ID	43-8167	43-8168	49-8000	43-8161	43-8161 D	43-8160	43-8159	43-8159 D	43-8001	43-8157	43-8156	43-8155	43-8164	43-8163	43-8162	43-8002
Gravel	0.9	1.4	0.0	0.0		0.0	0.0		0.2	0.0	0.1	2.0	8.8	4.5	0.0	0.0
Sand	93.5	41.7	43.7	86.2		1.5	2.5		71.1	52.6	19.1	37.6	83.3	93.7	49.7	21.9
Silt	5.5	49.4	48.3	12.0		73.5	54.0		26.6	42.4	56.4	27.6	7.1	1.7	41.7	69.7
Clay	0.2	7.4	8.0	1.8		25.1	43.5		2.2	5.0	24.3	32.8	0.8	0.1	8.6	8.4
TOC (%)	0.28	7.8	1.7	1.3		2.3	2.6		1.1	1.6	2.2	1.6	0.53	0.06	3.8	8.3
Zinc (mg/Kg, dry)	807	2,068	427	525	513	939	1,610	1,660	969	630	906	832	44.6	39.3	60.3	85.4
Lead (mg/Kg, dry)	188	305	54.0	39.6	38.2	97.8	198	205	50.2	30.8	90.8	101	8.0	8.6	10.0	45.9
Copper (mg/Kg, dry)	8.7	39.1	20.3	14.0	14.4	31.6	42.0	42.8	17.6	15.3	33.0	29.6	12.0	8.9	9.5	27.4
Chromium (mg/Kg, dry)	11.5	20.4	14.4	12.3	13.0	24.2	28.5	28.8	13.9	16.1	25.3	23.7	10.3	10.8	15.6	21.6
Nickel (mg/Kg, dry)	9.6	15.9	11.8	10.2	11.1	18.4	19.9	20.2	12.0	13.2	20.7	20.9	9.0	9.5	8.7	15.4
Cadmium (mg/Kg, dry)	1.7	17.7	3.1	3.6	3.2	10.7	18.4	18.7	7.0	2.8	5.5	5.3	0.5	0.53	0.5	0.4
Arsenic (mg/Kg, dry)	7.0	9.6	7.6	6.7	6.8	7.2	8.6	9.1	9.3	5.9	10.1	8.6	6.0	7.3	4.4	4.4
Beryllium (mg/Kg, dry)	0.32	0.64	0.63	0.44	0.46	1.0	1.2	1.2	0.51	0.53	1.1	1.1	0.36	0.34	0.74	0.8
Silver (0.3 ~ DL)	0.5	0.76	0.3	0.5	0.5	0.52	1.1	1.1	0.3	0.5	0.5	0.5	0.5	0.5	<0.5	0.3
Selenium (0.3 ~ DL)	0.3	0.32	0.3	0.3	0.3	0.3	0.31	0.3	0.54	0.3	0.36	0.3	0.3	0.3	0.60	0.56
Mercury (0.005 ~ DL)	0.012	0.25	0.026	0.034		0.11	0.25	0.25	0.030	0.032	0.081	0.096	0.0059	0.005	0.027	0.010
% Mort., H. azteca, 14-d	11.3	33.8	7.5	12.5		11.3	11.3		17.5	30.0	11.3	15.7	61.3	30.0	48.8	17.5
EC50 (ppm sed), Microtox	7,641	100000	14,795	59,388	45,140	4,993	3,416		32,431	4,644	5,297	8,983	100000	100000	884	89,401
Zinc (ug/L pore water)	103	92				52	43				226	84			3.7	
Lead (ug/L pore water)	67.5	47.6				13.4	8.9				41.4	12.7			2.1	
Cadmium (ug/L pore wtr)	2.2	1.0				1.40	0.55				4.3	0.75			0.1	



Hardness (mg/L)	210	143		237		122	131				106	132	557	250	334	
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Analytical Methodology: All samples come from the upper 2-cm in the grab sampler. All samples were freeze-dried. For all but Hg, 500-mg aliquots were digested with a combination of aqua regia/HF/HClO<sub>4</sub> in Teflon beakers at 200 °C. Be, Cr, Cu, Ni, Zn, and Tl were determined by ICP-AES, As, Sb, and Se by hydride generation AAS, and Cd, Ag, and Pb by flame AAS using an atom concentrator tube, mixed salt standards and background correction. Hg was determined on a separately digested 500-mg aliquot using LaFort Aqua Regia at 100 °C in Teflon beakers; quantitation was by cold-vapor AAS. TOC was determined on a 500 mg aliquot after treatment with treatment 10% HCl; quantitation was determined by evolution of CO<sub>2</sub> during combustion in a Leco Carbon Analyzer. A separated aliquot of freeze-dried bulk sample was dry-sieved at 63-gm using plastic meshes (one/sample) in a plastic frame on a shaker table; each sample was sieved for 15 minutes.

<sup>1</sup> All USGS analytical data has been validated internally using our own QA/QC procedures. However, it has not been validated by the U.S. EPA.